Not to be cited without
permission of the authors[1]

Canadian Atlantic Fisheries
Scientific Advisory Committee

CAFSAC Research Document 86/ 25

Ne pas citer sans
autorisation des auteurs[1]

Comité scientifique consultatif des
pêches canadiennes dans l'Atlantique

CSCPCA Document de recherche 86/ 25

Assessment of the Okak Assessment Unit Arctic Charr Population in 1985

by

J. B. Dempson and L. J. LeDrew
Fisheries Research Branch
Department of Fisheries and Oceans
P.O. Box 5667
St. John's, Newfoundland A1C 5X1

[1] This series documents the scientific basis for fisheries management advice in Atlantic Canada. As such, it addresses the issues of the day in the time frames required and the Research Documents it contains are not intended as definitive statements on the subjects addressed but rather as progress reports on ongoing investigations.

Research Documents are produced in the official language in which they are provided to the Secretariat by the author.

[1] Cette série documente les bases scientifiques des conseils de gestion des pêches sur la côte atlantique du Canada. Comme telle, elle couvre les problèmes actuels selon les échéanciers voulus et les Documents de recherche qu'elle contient ne doivent pas être considérés comme des énoncés finals sur les sujets traités mais plutôt comme des rapports d'étape sur les études en cours.

Les Documents de recherche sont publiés dans la langue officielle utilisée par les auteurs dans le manuscrit envoyé au secrétariat.

Abstract

The Okak assessment unit consists of Okak Bay and the Cutthroat subareas. Annual landings from this assessment unit have ranged from 5 to 76 t with a mean of 39 t during the past 12 years (1974-85). From 1977 to 1985 these landings have represented 26% of the total commercial production of Arctic charr from the Nain Fishing Region. The TAC in 1985 was 27 t but only applied to the Okak Bay subarea. Landings in 1985 totaled 33 t (25 t within Okak Bay) and were 83% higher than the previous year. Effort increased by 121%. A sequential population analysis was carried out on catch-at-age data from 1977 to 1985. Regressions of fishing mortality on fishing effort, and population biomass on catch per unit effort indicated a terminal fishing mortality in 1985 between 0.4 and 0.5. Projections of the TAC in 1986 fishing at $F_{0.1} = 0.4$ ranged from 38 to 48 t. Approximately 48% of the total landings from the Okak assessment unit during the past five years were from the Okak Bay subarea.

Résumé

Pour l'unité d'évaluation d'Okak, qui couvre les sous-zones de la baie d'Okak et de Cutthroat, les débarquements annuels se sont situés entre 5 et 76 t, la moyenne des 12 dernières années (1974-1985) s'établissant à 39 t. De 1977 à 1985, ces débarquements on représenté 26 % de la production commerciale totale de l'omble chevalier dans le secteur de pêche de Nain. En 1985, le TPA était de 27 t, mais ne s'appliquait qu'à la sous-zone de la baie d'Okak. Les débarquements se sont chiffrés à 33 t (dont 25 t pour la baie d'Okak), soit 83 % de plus que l'année précédente. L'effort de pêche a augmenté de 121 %. Une analyse séquentielle de population a été effectuée sur les prises par catégorie d'âge de 1977 à 1985. Des régressions de la mortalité due à la pêche sur l'effort de pêche et de la biomasse de la population sur les prises par unité d'effort révèlent une mortalité globale due à la pêche en 1985 se situant entre 0,4 et 0,5. Les projections du TPA pour 1986, à raison de $F_{0,1} = 0,4$, varient de 38 à 48 t. Environ 48 % des débarquements totaux enregistrés pour l'unité d'évaluation d'Okak au cours des cinq dernières années provenaient de la sous-zone de la baie d'Okak.

103-024237

Introduction

Catch statistics for the Okak Bay and Cutthroat subareas (Fig. 1) have been available since 1974. In past years assessments were carried out on the inshore Okak Bay subarea only. Quotas were applied to this stock beginning in 1981. On the basis of tag recapture information, these two subareas have now been considered as one assessment unit.

Annual landings from the Okak assessment unit have ranged from 18 to 76 t (excluding 1975) (mean = 39 t). Since 1977 landings from this assessment unit have represented 26% of the total commercial production of Arctic charr from the Nain Fishing Region. The TAC in 1985 for the Okak Bay subarea only was 27 t (Dempson and LeDrew 1985). This paper examines the results of the 1985 fishery and provides a forecast of available catch in 1986.

Stock Assessment

Catch and effort data

Catch and effort data for the Okak assessment unit are summarized in Table 1 for 1974-85. Landings in 1985 totaled 33 t and were 83% higher than those of the previous year. Landings exceeded the 1985 TAC by 23% although this TAC only applied to the inshore Okak Bay subarea. Effort increased by 121% while catch per unit effort decreased by 17%. The amount of fishing effort in these subareas has been influenced by the periodic fisheries in the more northern fiords. Lower effort values tend to coincide with the years when fisheries were conducted in the Hebron and Saglek Fiords (1981, 1982, and 1984).

Numbers at age were available since 1977 and are summarized in Table 2. Data were derived from annual commercial sampling programs. Numbers at age were estimated for each of the two subareas then added together. Numbers were then adjusted to reflect the total estimated number of fish caught for the entire stock unit. Mean age of the catch has varied from 9.5 to 12.0 years with no continuous increasing or decreasing trend.

Weights at age were calculated from commercial samples (1974, 1977-78 for yield per recruit analysis, and 1983-85 for stock projections) and were converted from gutted head-on to whole weight using the conversion factor 1.22 (Dempson 1984) (Table 3).

Total mortality (Z) was calculated using the Paloheimo method (Ricker 1975) and the average value for all years (excluding 1983-84) was 0.62. Assuming a natural mortality rate of 0.2 yields an estimate of fishing mortality of about 0.4. As in past years there was a considerable amount of variation in the estimates and a catch curve was also used to provide an estimate of Z. Using catch per unit of effort at age data from 1983 to 1985 a Z of 0.69 was obtained.

An initial cohort analysis was run using partial recruitment values and terminal fishing mortality (F_T) from the 1985 assessment (Dempson and LeDrew 1985) (F_T = 0.25). An iterative procedure was used to obtain estimates of

fishing mortality for the oldest age group (F_B) (Rivard 1982). Following this the cohort analysis procedure was rerun using the newly derived values for F_B.

Partial recruitment rates were calculated using the historical averaging method from a matrix of fishing mortality rates generated from the last sequential population analysis and are presented in Table 3.

Yield per recruit was calculated by the method of Thompson and Bell (Ricker 1975) using partial recruitment rates and mean weight at age. $F_{0.1}$ was 0.44 at a yield per recruit of 0.77 kg. This $F_{0.1}$ value was reasonably similar to those derived from the Nain and Voisey assessment units and for conformity, was rounded to 0.4 for the projections.

Cohort analyses were performed using a range of terminal fishing mortalities from 0.2 to 0.6 using the updated estimates of partial recruitment. In each cohort run, fishing mortality rates for the oldest age group (F_B) were re-calculated using the iterative procedure. Regressions of F on effort, and population biomass of fully recruited fish on catch per unit effort of fully recruited fish were used in tuning the analysis to determine the best estimate for F_T in 1985.

Regressions of F on effort and population biomass on CUE showed a decrease in the correlation coefficient with an increase in F_T (Table 4). The predicted value of F_T based on known effort for 1985 ranged from 0.42 to 0.54 from cohorts run with F_T ranging from 0.2 to 0.6. Residuals were lowest at higher values of F_T (Table 4). For regressions of biomass on CUE, residuals were lowest when F_T = 0.4.

Fishing mortality values in recent years are more highly influenced by estimates of F in the last year than those estimates F in distant years (1977-80). Cohort runs initiated with higher values of F_T (i.e. F_T = 0.35 - 0.5) appear to overestimate the value of F for 1984 relative to the fishing effort in that year. As a result, regressions of F on effort and biomass on CUE were rerun using data from 1977 to 1983.

Three indices were now used in the tuning process to determine the best estimate of F in the most recent year. These were: 1) the correlation coefficient, 2) residual of the last year to the regression line, and 3) the Y intercept (Mohn 1983). For 2 and 3, the absolute values are given in addition to the normalized values. Normalized values were obtained by dividing by the mean ordinate value of the points in the regression (Mohn 1983) to allow for more uniform comparisons. These results are summarized in Table 5.

Regressions of F on effort produced the highest correlation at F_T = 0.30 while the lowest residual and normalized residual were obtained when F_T = 0.45 (Table 5). Intercept values decreased with increasing F_T. The predicted value of F_T based on known effort in 1985 ranged from 0.38 to 0.45 for cohorts run with F_T varying from 0.2 to 0.6. Regressions of biomass on catch per unit effort had the highest correlation when F_T = 0.45 and the lowest residual and normalized residual when F_T = 0.4. Intercept values again decreased with increasing values of F_T. Mohn (1983) indicated that regressions of F on effort

were preferred to those of biomass on CUE. Mohn (1983) also indicated that the residual from the last point to the regression line performs better than the correlation coefficient in determining the best value of F_T, and both methods were better than using the intercept value.

A review of all methods suggests that F_T in 1985 was between 0.4 and 0.5. Paloheimo and catch curve estimates of F were 0.42 and 0.54 while regressions of F on effort using data from 1977 to 1984 also predicted values of 0.42 to 0.54. Regressions using 1977-83 data were statistically more significant and also tended to suggest a value of 0.4 to 0.5. As a result, a series of stock projections were run with F_T varying from 0.4 to 0.5. Recruitment was estimated from the geometric mean of population numbers for age six fish for years 1977-83. Weights at age for the projection were based on 1983-85 data. Table 6 summarizes the results of these projections.

Total allowable catch in 1986 for the Okak assessment unit ranges from 38 to 48 t. The highest value (48 t) was obtained by assuming F_T in 1985 was 0.40. The average catch during the past five years has been 36 t while during the past 10 years the average catch was 42 t. The Okak Bay subarea has contributed 48% of the landings for the stock unit during the past five years. This would suggest a TAC for the Okak Bay subarea in 1986 of 18 to 23 t.

References

Dempson, J. B. 1984. Conversion factors for northern Labrador Arctic charr landings statistics. CAFSAC Res. Doc. 84/6.

Dempson, J. B., and L. J. LeDrew. 1985. An assessment of Arctic charr stocks in Voisey Bay, Anaktalik Bay and Okak Bay in 1984 with stock projections for 1985. CAFSAC Res. Do. 85/12.

Mohn, R. K. 1983. Effects of error in catch and effort data on tuning cohort analysis, with a postscript on logistic production models. Can. Spec. Publ. Fish Aquat. Sci. 66: 141-150.

Ricker, W. E. 1975. Computation and interpretation of biological statistics of fish populations. Bull. Fish. Res. Board Can. 191.

Rivard, D. 1982. APL programs for stock assessment (revised). Can. Tech. Rep. Fish. Aquat. Sci. 1091.

Table 1. Summary of catch and effort statistics for the Okak assessment unit, 1974-85. Quotas and landings are in kg-round weight, effort is expressed as man-weeks fished.

Year	Quota	Landings	Effort	CUE
1974		46,891		
1975		5,057		
1976		25,338	148	171
1977		42,392	243	174
1978		76,024	352	216
1979		43,261	283	153
1980		49,035	253	194
1981	27,300	47,541	202	235
1982	27,300	34,171	186	184
1983	21,000	48,978	286	171
1984	27,000	18,146	94	193
1985	27,000	33,261	208	160

TABLE 2. ESTIMATED CATCH AT AGE FOR THE OKAK STOCK UNIT, 1977-85.

	1977	1978	1979	1980	1981	1982	1983	1984	1985
6	84	205	1	130	39	93	475	251	17
7	139	2465	1989	638	526	713	1762	1371	2675
8	417	8163	7462	5631	2135	2760	4471	2336	4948
9	1084	5494	4997	9175	7166	4167	5787	2151	5385
10	2667	5594	3299	6487	7615	3848	5601	1850	2740
11	3388	3747	1954	2863	4673	3622	5169	2211	2936
12	5417	3953	878	1382	1330	1542	4075	1472	987
13	2278	2773	761	407	1044	444	1643	1180	740
14	1694	514	527	350	459	342	658	587	768
15	1472	1027	410	262	359	183	307	219	103
16	832	308	351	90	44	57	107	127	75
17	139	411	234	129	145	38	11	12	50
18	139	103	95	33	48	15	43	1	6
19	139	117	138	61	132	1	63	35	56
TOTAL	19889	34874	23096	27638	25715	17827	30172	13803	21486
MEAN AGE	12.1	10.1	9.6	9.6	10.2	9.9	10.1	10.1	9.5

Table 3. Summary of weight (kg round) at age data, partial recruitment rates and calculated $F_{0.1}$ for the Arctic charr population of the Okak assessment unit.

Age	Weight		Partial recruitment
	1974, 1977-78	1983-85	
6	1.58	1.14	0.003
7	1.59	1.29	0.041
8	1.73	1.50	0.228
9	2.00	1.69	0.678
10	2.21	1.84	1.0
11	2.25	1.82	1.0
12	2.49	1.96	1.0
13	2.45	1.85	1.0
14	2.52	1.89	1.0
15	2.75	1.81	1.0
16	2.72	1.84	1.0
17	2.50	2.08	1.0
18	2.73	2.69	1.0
19	2.83	2.48	1.0

$F_{0.1}$ = 0.44 at a Y/R of 0.77 kg.

Table 4. Results of regressions of F on effort and population biomass on catch per unit effort from cohort analyses run with various terminal fishing mortalities (F_T) for the Arctic charr population of the Okak stock assessment.

Regression	Parameter	F_T 0.2	0.25	0.3	0.35	0.4	0.45	0.5	0.6
F (weighted 11+) on effort 1977-84	r	0.76	0.73	0.70	0.66	0.61	0.57	0.52	0.43
	residual (absolute value)	0.22	0.19	0.16	0.13	0.10	0.06	0.02	0.06
11+ biomass on CUE of 11+ 8 fish 1977-84	r	0.70	0.67	0.61	0.56	0.52	0.48	0.45	0.41
	residual (t) (absolute value)	21	12	6	2	2	4	6	9

Table 5. Results of regressions of F on effort and biomass on catch per unit effort using data from 1977 to 1983, for cohort analyses run with various terminal fishing mortalities.

Regression	Parameter	F_T 0.2	0.25	0.3	0.35	0.4	0.45	0.5	0.6
F (weighted 11+) on effort 1977-83	r	0.729	0.738	0.740	0.736	0.730	0.722	0.715	0.699
	residual (absolute value)	0.18	0.15	0.11	0.07	0.03	0.01	0.06	0.15
	normalized value	0.36	0.29	0.21	0.14	0.06	0.02	0.10	0.26
	y intercept	0.10	0.08	0.07	0.06	0.05	0.04	0.04	0.03
	normalized value	0.21	0.16	0.13	0.11	0.09	0.07	0.07	0.05
11+ biomass on CUE of 11+ fish 1977-83	r	0.770	0.835	0.860	0.874	0.879	0.880	0.879	0.874
	residual (t) (absolute value)	22	13	6	2	1	4	6	9
	normalized value	0.58	0.36	0.19	0.07	0.03	0.11	0.17	0.21
	y intercept	16	14	14	13	13	12	12	11
	normalized value	0.44	0.40	0.41	0.39	0.39	0.38	0.37	0.36

Table 6. Summary of projected available catch for 1986 with F_T in 1985 varying from 0.4 to 0.5.

	F_T in 1985		
	0.40	0.45	0.50
TAC in 1986 (kg)	47,906	42,399	38,141

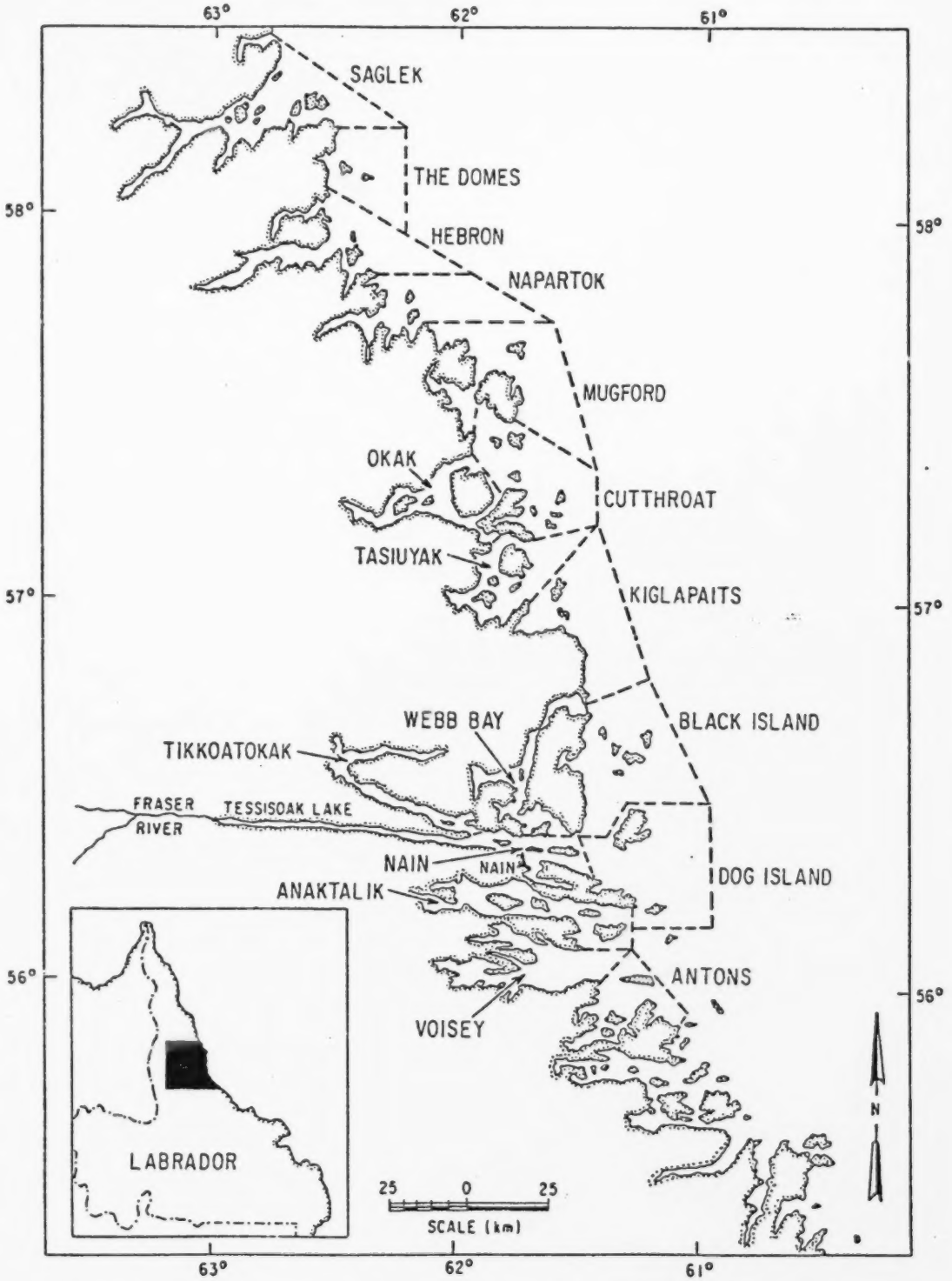

Fig. 1. Geographic separation of Nain Fishing Region subareas.